CLAIMS

1. A method of forming metal patterns on a substrate, comprising:

a) forming an electroless active layer over at least a portion of the substrate;

b) defining a pattern on the electroless active layer;

c) ink-jetting a metal composition on the pattern, said metal composition including a metal salt; and

d) ink-jetting a reducing agent composition on the pattern, said reducing agent composition including a reducing agent,

wherein the reducing agent contacts the metal composition and reacts with the metal salt to form a reduced metal.

2. The method of claim 1, wherein the metal of the metal salt is selected from the group consisting of palladium, copper, silver, gold, nickel, cobalt, platinum, rhodium, and mixtures or alloys thereof.

3. The method of claim 2, wherein the metal composition further comprises a metal salt of palladium.

4. The method of claim 2, wherein the metal salt is a member selected from the group consisting of $Pd(NH_3)_4Cl_2$, $Pd(NH_3)_4Cl_2 \cdot H_2O$, $Pd(NH_3)_4(NO_3)_2$, $Pd(NH_3)_4(NO_3)_2 \cdot H_2O$, $PdCl_2$, $AgNO_3$, $Cu(NO_3)_2$, $CuSO_4$, $CuSO_4 \cdot 5H_2O$, $KAu(CN)_2$, $Na_3Au(S_2O_3)_2$, $NiSO_4$, cobalt salts, and mixtures or hydrates thereof.

5. The method of claim 4, wherein the metal salt is $Pd(NH_3)_4Cl_2$.

6. The method of claim 1, wherein the reducing agent comprises a member selected from the group consisting of formaldehyde, hydrazine, sodium hypophosphite, sodium borohydride, dimethylaminoboran, sodium L-ascorbic acid, and mixtures thereof.

7. The method of claim 6, wherein the reducing agent is hydrazine.

8. The method of claim 1, wherein the substrate comprises a member selected from the group consisting of ceramics, polymers, cellulose, glass, silicon, organic substrates, metal oxides, and mixtures or composites thereof.

9. The method of claim 1, further comprising heating the metal composition and reducing agent compositions on the pattern, wherein the heating is performed at a temperature from 20 °C to about 90 °C.

10. The method of claim 1, further comprising the step of forming multiple layers of reduced metal by repeating the ink-jetting of metal composition and reducing agent composition such that the reduced metal has a predetermined depth.

11. The method of claim 10, wherein the predetermined depth is from about 0.01 μm to about 100 μm.

12. The method of claim 1, wherein the reducing agent is ink-jetted on the pattern in an offset area with respect to the metal composition, wherein a portion of each of the metal composition and reducing agent composition are not ink-jetted on the same portions of the pattern.

13. The method of claim 1, wherein the active layer is formed by depositing an electroless initiator on the substrate.

14. The method of claim 13, wherein the electroless initiator comprises a member selected from the group consisting of palladium, aluminum protected copper, silver, and mixtures thereof.

15. The method of claim 14, wherein the electroless initiator is a mixture of palladium and tin.

16. The method of claim 13, wherein the electroless initiator is deposited by ink-jetting.

17. The method of claim 13, wherein the electroless initiator is deposited by immersing the substrate in a solution of electroless catalyst salt.

18. The method of claim 13, wherein the electroless initiator is deposited in a non-continuous pattern.

19. The method of claim 1, wherein the active layer is formed by marring the substrate along the pattern.

20. The method of claim 1, wherein the pattern is a circuit.

21. A substrate having a circuit formed thereon, said circuit prepared by the method of claim 1.

22. A system for forming metal patterns on a substrate, comprising:

a) an activation system configured to form an electroless active layer on the substrate;

b) a first printhead having a first firing chamber reservoir containing an ink-jettable metal composition, said ink-jettable metal composition including a metal salt; and

c) a second printhead having a second firing chamber reservoir containing an ink-jettable reducing agent composition, said ink-jettable reducing agent composition including a reducing agent.

23. The system of claim 22, wherein the metal salt is a palladium salt.

24. The system of claim 22, wherein the reducing agent comprises a member selected from the group consisting of formaldehyde, hydrazine, sodium

hypophosphite, sodium borohydride, dimethylaminoboran, sodium L-ascorbic acid, and mixtures thereof.

25. The system of claim 22, wherein the activation system includes a third printhead having a third firing chamber reservoir containing an ink-jettable electroless catalyst.

26. The system of claim 22, wherein the activation system includes a tip configured for marring the surface in a predetermined pattern.

27. The system of claim 22, wherein the electroless catalyst comprises a member selected from the group consisting of palladium, aluminum protected copper, silver, and mixtures thereof.

28. The system of claim 22, wherein the substrate comprises a member selected from the group consisting of ceramics, polymers, cellulose, glass, silicon, organic substrates, metal oxides, and mixtures or composites thereof.

29. The system of claim 22, wherein the substrate further includes a thin hydrophobic layer deposited thereon.

30. A system for forming metal patterns on a substrate, comprising:

a) means for forming an electroless active layer on the substrate;

b) means for printing an ink-jettable metal composition on at least a portion of the electroless active layer, said ink-jettable metal composition including a metal salt; and

c) means for printing an ink-jettable reducing agent composition on at least a portion of the electroless active layer, said ink-jettable reducing agent composition including a reducing agent,

wherein the metal composition and the reducing agent composition are contacted to form a reduced metal.